A Dynamic Food Science Internship Program: Integration of Problem-Based Learning and Student-Centered Mentoring

Y.M. Lo, S.L. Gdovin, J.B. Stankiewicz, L. Appezzato, and E.M. Garvey

ABSTRACT: An internship program based upon problem-based learning (PBL) and student-centered mentoring is developed. Food science majors are introduced to the program in their sophomore/junior year and follow a process that involves learning-style assessments, career counseling, and direct contact with industrial mentors to develop a resume. The problems are designed in collaboration with a faculty advisor so the students can apply their knowledge to industrial situations. Assessment of performance is conducted by having students submit weekly journal entries and a final report and participate in a closing interview. The journals and reports are graded on 6 aspects of a pedagogical reasoning model: comprehension, transformation, implementation, evaluation, reflection, and new comprehension. This trains students to use a range of knowledge within a restrained environment, as well as assisting students to refine the critical food science and interpersonal skills needed for successful careers after graduation.

Introduction

The scientific discipline encompasses multidisciplinary research efforts, and food science is where many complicated science and engineering theories find their applications (Hopper 1990). The study of food science provides “hands-on” and “minds-on” experiences with real-world applications for foundational principles in science. Recent development of food science and technology has made the food industry one of the fastest growing ones in the twentieth century, both domestically and worldwide. As the demand for nutritious and convenient products increases, so does industry’s need for many well-trained professionals to develop healthier products, improve processing technologies, and monitor the safety of these products. Introduction of real-world food science problems and their practice of finding appropriate solutions are essential to better prepare the future workforce for this modernized industry (Iwaoka and others 1996). It is critical to have students develop and practice these skills, especially with today’s large-scale automated operations that are highly sensitive to quality variations (Ilyukhin and others 2001).

Field experience or an internship has been part of food science undergraduate education for many years (Wasserman and Wasserman 1993). Most of the internships, however, are arranged by faculty members or their food industry colleagues on a case-by-case basis. As the industry becomes more complex, traditional approaches and structures in the internships are challenged to keep up with the changing demands and expectations of the students (Iwaoka and others 1996).

In the past, much of science learning in higher education has been rote. It is being called into question and alternative forms of learning are now being explored (Lajoie and others 2001). Research has clearly demonstrated that the more students become involved with the “real life” situations, the more they learn (Nolinske and Millis 1999). This statement is particularly critical for food science education as new technologies emerge. One approach that enables students to utilize their knowledge and to develop their reasoning skills within a discipline area is problem-based learning (PBL) (Peterson and Treagust 1998). The key principle of PBL is that the problem is encountered first by the students, and the learning that takes place is in response to the students’ attempts in resolving the problem. It has been shown that, with PBL approach, complex, real problems motivate students to identify and research concepts and principles they need to know in order to solve the problems (Bonwell 1999; Fink 1999). However, most PBL problem scenarios are designed in a classroom setting, limiting the students to hypothetical situations without restraint of time, a critical factor in many decision-making processes.

Moreover, educational experiences with a proactive approach that encompass both cognitive and motivational goals must become the core emphasis (Richardson 1999). It is believed that an effective learning process will assist the students in meeting the content and process skills expected by the industry. The objectives of this paper are: (1) to describe the establishment of an internship program integrated with student-centered mentoring to achieve an active PBL mode; and (2) to demonstrate how this program assisted students in enhancing problem-solving skills as well as in formulating and pursuing their career goals.
Materials and Methods

Internship structure

Figure 1 shows a schematic diagram of the internship program designed to facilitate student placement from smaller Food Science programs, such as those at the Univ. of Delaware and of Maryland. Although most students registered for the 2-credit-hours internship during their senior year, this schematic shows that a series of preparative activities started as early as during the sophomore year. First, students were asked to compose a list of prospective career goals, based on which at least 1 industrial mentor was identified and paired up with the student via the mentorship program established with Institute of Food Technologists (IFT) Sections (Philadelphia and Maryland).

At the beginning of the junior year, each student was asked to study the career opportunities listed in recent issues of Food Technology and to consult with the Univ. Career Services to identify their career goals. The student assessed career opportunities and potential challenges, such as the company’s primary products and their market, the responsibility and mobility of the working environment, and location and wages, and so on. Resumes were prepared based on the students’ career goals, self-assessment, and on the knowledge and skills they have acquired. Mentors then advised the students on how they could benefit themselves the most by applying to a particular area in the industry. To prepare the students for the actual interview, the advisor offered a series of questions the potential employers might ask during interview. In addition, the mentors also provided industrial contacts to whom students could submit their resumes.

Each internship experience was centered around a problem. The PBL scenario was carefully defined in collaboration with an advisor based on 3 knowledge base components: subject matter (science content) knowledge, knowledge of learner (self), and knowledge of educational purposes and values (Peterson and Treague 1998). Bearing the problem in mind, the students were then asked to actively seek opportunities in the related areas. Finally, the actual internship was conducted during the student’s senior year, either during summer or winter break. They were expected to identify situations where decisions were made collaboratively between marketing and technical departments throughout the course of the internship. They were also asked to evaluate the pros and cons of the decisions made, with emphasis on how to develop necessary skills to deal with similar situations.

Prerequisites

Since mentors played an important role in this program, it was crucial to ‘prime’ the mentors so that they could contribute effectively. All mentors who participated in our program were interviewed by the internship coordinator after reading “Powerful Partnerships: A Shared Responsibility for Learning” (AAHE 1998). This report, published in June, 1998 clearly demonstrates 10 learning principles and collaborative actions that are extremely helpful to the mentors in providing guidelines on how to create a “student-centered” relationship with students and how they can assist the students in setting up career plans. The advisor should have discussed with the supervisor upon setting up the internship how to foster meaningful learning while also assessing the integrity of the problem, that is, not reducing the complexity to routine procedures and rote learning. All the supervisors that we worked with had been highly supportive and were willing to assist in the grading process.

Depending on the nature of the positions for which students would apply, various activities were designed before the internship to enhance student knowledge and skills. After a preliminary consultation with their mentors and the Center for Teaching Excellence, students were assessed using the Kolb’s Learning Style Inventory (Svinicki and Dixon 1987) and the Keirsey Temperament Sorter (Bonwell and Eison 1991) to identify their learning style and to provide a conceptual framework for understanding students’ positive or negative reactions to strategies promoting active learning. Table 1 lists several activities that could be easily incorporated into a student’s regular course schedule. Both Independent Study and Special Problems carried at least 1 credit hour during the semester and were counted towards their graduation. For instance, for a student interested in working for SPI Polyols, the Independent Study was geared towards subjects such as “Sugars Substitutes” or “Sweetening Agents in Food.” Laboratory rotation, on the other hand, was provided to students interested in laboratory research or graduate school.

Design of problem scenario

Fundamental to the problem scenario was the knowledge of the subject matter or the science content. Since the students should have taken most of the basic Food Science courses before participating in the internship, this component thus came first and was easy to incorporate. Knowledge of learner (self) is often neglected in the design of PBL problem scenarios. However, the PBL approach moved from information dissemination to a situation where the learning was student-centered with students exeracting much more control over the learning to be completed. The last knowledge base component was the knowledge of educational purposes and values, which enabled the advisor to interweave the...
Integrated food science internship:...

Table 1—Typical activities involved during preliminary assessment before interview.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Independent Study: Students work with one of the faculty members to conduct independent research work equivalent to 1 credit hour during the semester</td>
<td>Advisor</td>
</tr>
<tr>
<td>(2) Special Problems: Students interested in a special topic will conduct literature reviews and identify solutions targeting problem areas (1 credit hour)</td>
<td>Advisor</td>
</tr>
<tr>
<td>(3) Laboratory Rotations: Students rotate through food science research laboratories and work with graduate students to learn basic laboratory skills</td>
<td>Advisor</td>
</tr>
</tbody>
</table>

The theme of the internship with students' further educational or discipline-specific interests.

In addition, use of Primary Trait Analysis (PTA) (Lloyd-Jones 1977) was highly valuable in the design of our problem scenarios. Once the student and the advisor had identified a generic area of interest, for example, Food Chemistry or Microbiology, the advisor was responsible for (1) selecting traits that would count for the grade (such as "comprehension", "solution identification", "control of variables", and "creativity") and (2) constructing a 5-point scale using descriptive statements for scoring the student's performance on that trait. Depending on the subject area, most problems were designed based on only 1 or 2 traits. For example, "comprehension" is a good trait for students working in Quality Assurance. By choosing the question "What happens when chemistry principles don't apply?" to represent a Food Chemistry problem scenario, a typical 5-point scale was designed as:

- (1) Student merely identifies the problem or does not address the problem
- (2) Student describes the problem
- (3) Student explains the problem
- (4) Student analyzes the problem
- (5) Student synthesizes the problem

A list of traits that had been employed in the current study is provided in Table 2. It is important to note that the scale is not additive or subtractive—each level represents a different skill in pedagogical reasoning, a valuable tool for student assessment. Integration of the pedagogical reasoning model in the internship program will be explained in detail in the following section. Examples of PBL-based problems derived from PTA traits are listed in Table 3.

Grading criteria

Evaluation and grading on student performance is more challenging for an internship than any classroom testing. In order to reflect the 6 aspects of the pedagogical reasoning model (comprehension, transformation, implementation, evaluation, reflection, and new comprehension), the 5-point scales derived from PTA were employed. The final grade for the course was calculated based: (1) 60% on the weekly journals graded by both the advisor and the internship supervisor; (2) 30% on the 5-page final report, and (3) 10% on the closing interview with the advisor and the internship supervisor.

The students were encouraged to submit their weekly journals based primarily on the following format: (a) problem statement, (b) assigned responsibility, (c) available resources, (d) possible approaches, (e) description of experimentation or implementation processes, (f) results and discussions, and (g) evaluation and recommendation. Grading of weekly journals was focused on how the interns handle "real-world" challenges within and beyond expectations. In general, the journals were graded in a 'progressive' manner. At the beginning of working on a particular task during the internship, the student needed to comprehend both the science content and available resources as the 1st part of their journal report (Level 1). In the 2nd or 3rd journal, the student had to consider the potential pitfalls and determine the most appropriate approach, that is, transforming the information for accomplishing the task. In this transformation process, the student was expected to integrate the content knowledge required for this task (Level 2). As soon as and after the student entered the implementation process (Level 3), the student should have evaluated and reflected on various outcomes of the situation (Level 4), and, as a result, was expected to develop a new understanding or new comprehension of the topics pertinent to the task in question (Level 5).

The grading criteria of the final report were provided to the students in the beginning of the internship based on a 5-point scale that begins with a 5 and then subtracts:

- (5) Report is arranged in a logical, coherent manner
- (4) Clearly states the 'problem'
- (3) Recognizes and explains results that are unexpected
- (2) Integrates content knowledge and scientific terminology in the explanation
- (1) After the student's final report was submitted, a closing tele-

Vol. 1, 2002—JOURNAL OF FOOD SCIENCE EDUCATION 47
phone interview was conducted by telephone-conferencing with the internship supervisor. Prior to the interview, students were given a hypothetical product a company is about to launch with the availability of processing capacities similar to the company that he/she worked for. Desirable quality measures (texture, appearance, packaging, shelf-life, and so on) were also provided along with challenges anticipated so that the student can form a hypothesis and start collecting evidence. During this interview, students were asked to present how they came up with the approaches based on the collected evidence. Similar grading criteria based on the PTA 5-point scale were used (Table 4).

Program assessment

According to the Fourth Principle of the AAHE’s Principles of Good Practice for Assessing Student Learning, “assessment requires attention to outcomes but also equally to the experiences that lead to those outcomes” (Walvoord and Anderson 1998). Although demonstration of the effectiveness of this internship program suffers from the same methodological limitations of any student outcome studies, we have included the outcome variables of (1) specific skills acquired and (2) knowledge and utilization of activities involved throughout the program using a case study approach (Peterson and Treagust 1996). The students who have completed the internship are first polled to determine how enjoyable and worthwhile the individual activities have been for them (Table 5). The students are then interviewed as a group to share ideas and experiences as to how the program can be refined and strengthened.

In addition, the students were asked to identify the relative importance of the activities employed in the preparation of the actual internship. To further elucidate the effectiveness of the internship program in question, we had also gathered information regarding the internship experience (including their responsibilities) that each of the students participated and tabulated with their current position or status (as of May 31, 2001). Their career path and professional development have been continuously monitored and the data are being collected for further analysis.

Results and Discussion

Internship structure

Due to the diversity of Food Science as a subject matter, it would be virtually impossible for a small department to maintain strong training opportunities in all of its subject areas without involving career Food Scientists from diverse food companies. With this internship program, the students were able to interact with their mentors from a wide spectrum of food industry applications. In addition to sharing their industrial expertise and experience, it was expected that, by familiarizing the mentors with student-centered advising strategies, the mentors could serve not only as a lever for this internship, but, in the long run, as role models for the students. The diversification of mentors, on the other hand, also constituted a distinct advantage because most mentors participated in the program out of shared interest in the training of a better workforce for the food industry.

Feedback via personal communication with students graduated over the 5 years (1996 to 2001) when the corresponding author was with the Univ. of Delaware indicated that student perceptions and perspectives were of critical importance to the health and success of an internship program. Since the food industry was not considered one of the major industries in the Mid-Atlantic metropolitan areas, the earlier the students were made aware of potential career opportunities, the more likely they were to be prepared for the internship. Additional reasons for early internship awareness include: (1) sophomore year was the year that students start taking entry-level Food Science courses taught in the College of Agriculture and Natural Resources, hence having more opportunity to develop direct contacts with faculty members; (2) it was also the year that most transfer students from various departments across campus being accepted into the Food Science program. Despite the fact that some of the students might have transferred out of their original major due to difficulties in comprehending the opportunities and/or challenges presented to them, the majority of the transfer students did show high level of interest in seeing applications of nutrition, chemistry, biology, or engineering principles in food.

Importance of prerequisites

As shown in Figure 2, among all the major activities, identification of internship problem scenario was ranked the most important (57%), followed by the establishment of career goals (17%).Resume preparation and learning style characterization were also considered of great value to the students, both at 13%. It has recently been demonstrated that students’ learning style (Claxton and Murrell 1987) and stages of students’ intellectual development (Belenky and others 1986; Perry 1968) are of essential importance in any teaching and learning activity. However, unfortunately, due to the limited number of answers obtained, it is not appropriate to declare any significance among these values. We could only view them as relatively important activities that caught the attention of the students and later on translated into positive assets during their internship.

The key factors contributing to the success of internship were identified and ranked (Table 6). It is not surprising to see the significant role academic advisors and industrial mentors played in...
this program, as they were the key people working with students throughout. The career information provided by IFT and its regional section was also highly appraised by the students. The prerequisites, along with the interview rehearsal, thus provided students a first-hand experience that they could continue to improve on as they build their confidence and skills.

**Student performance**

During the academic years of 1998 to 2001, at least 12 undergraduate students in the Food Science program at the Univ. of Delaware were placed into internships via this program with a grade average of 90.4 ± 3.1 from the internship. In this study, most PBL scenarios were focused on the development of a knowledge base for a particular subject area. However, we have tried to extend the subject area beyond the content per se and encouraged the student to consider knowledge from a range of sources. For example, students interested in the marketing aspects of food were placed in a marketing- or product development-oriented environment. Although it is impossible to clearly demonstrate the correlations between learning style and the internship students take by using the limited data from the present study, it is reasonable for the authors to speculate a close dependency based on their observation. Students who were more intellectually involved than others tend to take on research-oriented opportunities, whereas those comfortable with interpersonal skills seemed to have enjoyed roles involving supervision and/or management. In either case, all the students were able to provide possible solutions to their ‘problem’ with in-depth observation and linkage to the knowledge they have acquired.

The top 5 most important skills acquired via this integrated internship program as identified by the students are tabulated in Figure 3. Although laboratory skills appear to be the one most students checked off on the written survey conducted at the end of their internship, most students actually praised interpersonal and presentation skills and contacts as the most important benefits of their internship experiences. Regardless of the actual ranking of these skills required, it is obvious that after completing the internship many students have become more mature and responsible team players than they were before. Positive feedback was gathered from the internship evaluation (Table 7). We have also found that students who have undergone this internship program tend to stay in touch with their advisor and were more willing to participate in educational activities such as guest lectures for freshmen and various recruitment efforts.

---

### Table 6—Rank of the key factors/activities contributing to the success of internship.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Factors/Activities</th>
<th>Major Student Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic advisors</td>
<td>Provide information and resources</td>
</tr>
<tr>
<td></td>
<td>Industrial mentors</td>
<td>Offer broad view of the industry</td>
</tr>
<tr>
<td></td>
<td>IFT</td>
<td>Excellent role model</td>
</tr>
<tr>
<td></td>
<td>Prerequisites</td>
<td>Give access to opportunities locally and worldwide</td>
</tr>
<tr>
<td></td>
<td>Interview rehearsal</td>
<td>Good resources for career development</td>
</tr>
<tr>
<td></td>
<td>Periodic journal</td>
<td>Important step in understanding self taken with an interview</td>
</tr>
<tr>
<td></td>
<td>Survey</td>
<td>Need to be thorough and true</td>
</tr>
</tbody>
</table>

Table 7—The self-assessment form used at the end of the internship.

**Instructions:**

**Use the key that follows; circle the number that represents your opinion on your performance on each item.**

- 3 = Outstanding
- 2 = More than satisfactory
- 1 = Satisfactory
- 0 = Less than satisfactory
- N/O = Inadequate opportunity to assess

**Work-Related Performance**

- Comprehension: Seemed to understand requirements for assignment
- Problem identification and solution: Comfortable in identifying problems and working toward solutions
- Organization: Approached tasks (such as time management) in systematic manner
- Acceptance of responsibility: Shared responsibility for tasks to be accomplished
- Invitation/motivation: Made suggestion, sought feedback, showed interest in group decision making and planning
- Task completion: Followed through in completing own contributions to group project
- Attendance: Attended planning sessions, was prompt, and participated in decision making

**Work-Related Interactions with Others**

- Collaboration: Worked cooperatively with others, participated in group decision making and planning
- Independence: Carried out assigned tasks without overly depending on other group members
- Communication: Made suggestion, sought feedback, made constructive comments in working toward goal

**Overall effectiveness**

Through direct conversations with the participants, we have learned that both students and their industrial supervisors found their experiences with this program both enjoyable and successful. With rare exception, the students were able to find directly related employment soon after graduation. As can be seen in Table 8, seven students were hired by companies within their career plan upon graduation; 4 went on to graduate schools or equivalents; whereas one of them is preparing for her 2nd internship. Although only 2 of them continued to pursue graduate degrees in Food Science, one of the students is currently enrolled in a Dentistry program and another in pursuit of her Medical Doctor degree.
The retention rate of students staying with Food Science-related programs and the food industry was higher than 83% (10 out of 12). Equally noteworthy is that, with the 2 who were successfully accepted into Dentistry and Medical School, it is evident that the quality of Food Science students as well as the depth of scientific training and aptitude offered by a Food Science program remain competitive.

It has been recommended that analysis of student grades before and after undergoing a new teaching practice is implemented should offer a quantitative representation of the effectiveness of the new practice (Phelan and others 1993). However, the authors believe that the quality and strength of the internship program could be measured using different approaches to reflect changes in the student's academic performance. At the Unv. of Delaware, for instance, where the low enrollment in the Food Science undergraduate program (less than 20) allowed very limited data for the study, an analysis on grades could never be statistically valid. The first author has started implementing the same program at the Univ. of Maryland and recruited 2 students to participate in this program. Hence, with more and more data collected, the effectiveness of this ongoing program could be thoroughly evaluated with both qualitative and quantitative methodologies.

Conclusions
An internship program based upon problem-based learning (PBL) and student-centered mentoring has been developed. A series of prerequisites were employed to prepare industrial mentors for student-centered advising and to help the students to understand their learning style. Each internship experience was centered on a problem designed in collaboration with a faculty advisor using primary trait analysis (PTA) derived from the 6 aspects of the pedagogical reasoning model so the students could practice how to apply their knowledge to an industrial problem situation. An evaluation process based on the 5-level PTA scales was employed, including weekly journals, a final report, and a closing interview. Both the students and their industrial supervisors found their experience with this program enjoyable and successful. Enhancements in students’ content and problem solving skills were also observed in addition to improvements in their interpersonal and presentation skills.

References
Integrated food science internship. . .


The authors would like to thank Ms. Jennifer E. Cleveland, a former undergraduate student in the Food Science program at the Univ. of Delaware, for initiating the industrial mentor program via the Philadelphia Section of IFT. Gratitude is extended to all students, mentors, and companies who have participated in this program, as well as the Univ. of Delaware Center for Teaching Effectiveness and Career Services. The willingness of the Univ. of Maryland Center for Teaching Excellence to participate and assist in further development and assessment of this internship program is extremely encouraging. Assistance provided by Ms. Chia-Hua Hsu, Brenda C. Fermin, and Jennifer E. Cleveland during manuscript preparation is also highly appreciated.

Y. Martin Lo is with the Dept. of Nutrition and Food Science, Univ. of Maryland, College Park, Maryland 20742. Susan L. Gdovin is with the Center for Teaching Excellence, Univ. of Maryland, College Park, Maryland 20742. Jill B. Stankiewicz, Lisa Appezzato, and Erin M. Garvey are with the Dept. of Animal and Food Sciences, Univ. of Delaware, Newark, Delaware 19717. Direct inquiries to Y. Martin Lo, Dept. of Nutrition and Food Science, 3304 Marie Mount Hall, Univ. of Maryland, College Park, Maryland 20742-7521; e-mail: ymlo@umd.edu